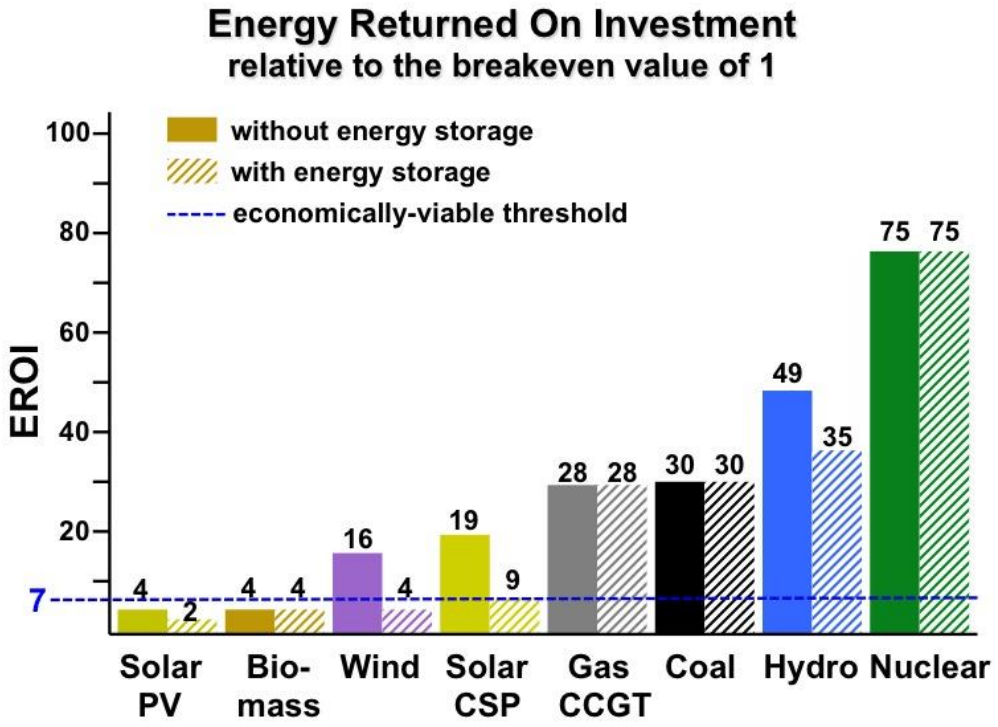
2017

The Case for the Good Reactor



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The Case for Nuclear Reactors

Why Do We Need Nuclear?

Coal and fossil fuels have lifted mankind out of hard labor and poverty but with an increasingly high environmental cost. The truth about nuclear is quite simple. Only nuclear power can lift all the World's poor out of energy poverty without cooking the planet, or keeping cities like Delhi and Beijing caked in deadly particulate matter, or extinguishing ocean life.

Solar and wind are too diffuse and not reliable enough to power factories and cities. Thus they cannot lift people out of poverty nor reduce emissions from fossil fuel-powered electrical systems more than modestly -- both depend on combustion power for daily backup. http://www.environmentalprogress.org/energy-and-environment/

Jacobson 2050 Roadmap for an All-electric society:

http://news.stanford.edu/pr/2015/pr-50states-renewable-energy-060815.html

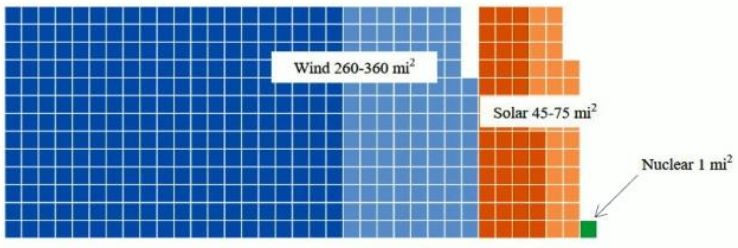
- Utilize existing renewables and pumped hydro storage
- Expand existing hydro dams
- Install 1,515 GW of new-build renewables
    - Solar on land equal to Maryland, Rhode Island and Connecticut
    - Wind on land equal to New York
    - Offshore wind in areas larger the West Virginia
- Bare-bones Cost $15.2 Trillion (Jacobson agrees with this price)
    - With 4 hours of storage additional pumped hydro $16.5 Trillion
    - With 24 hours of storage pumped hydro $22.8 Trillion

Land Requirements for Carbon-Free Technologies

http://tinyurl.com/jcn2pjj

Technology	Capacity Factor, %	Square Miles Needed for 1,000 MW
Wind	32-47	260-360
Solar	17-28	45-75
Nuclear	90	1.3

The table summarizes the approximate land required by wind and solar technologies to match the electricity produced annually by a 1,000-MW nuclear power plant.



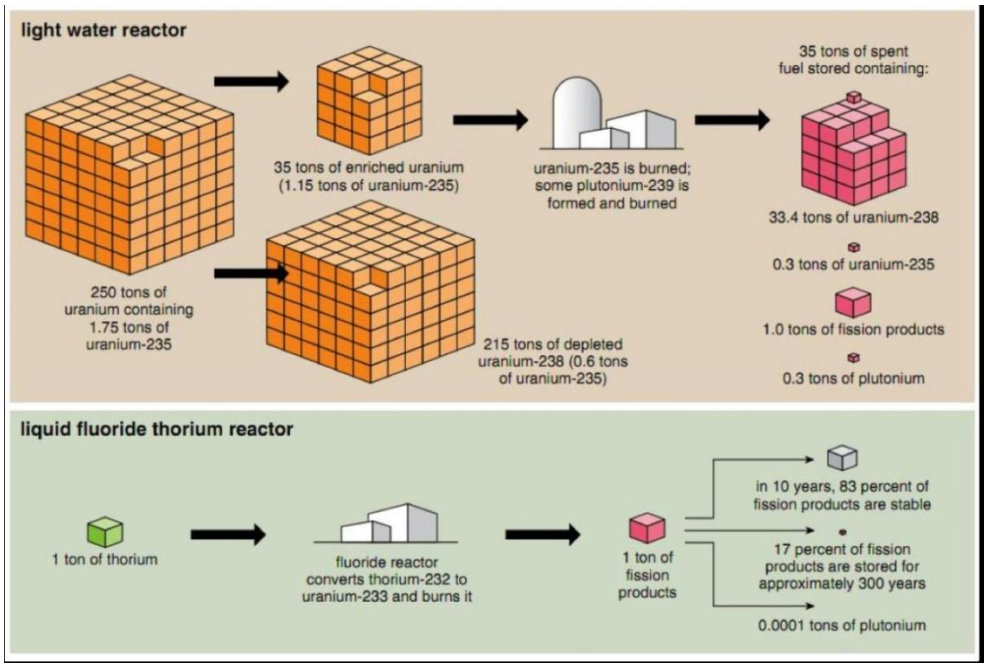
The Nuclear 2050 Roadmap

- Use existing renewables, pumped hydro and hydro dams
- Install 1,515 GW of Molten Salt Reactors $3 Trillion on land area equal to one-half of Long Island including full security perimeters
- Copyright © 2017 by Michael Sean Conley

Why the "Good Reactor" for New Reactor Power Plants?

Old Nuclear is based upon the Pressurized/Boiling-Water Reactor, which was designed for nuclear submarines and is very manageable in the small power form factor. We must keep the current fleet in operation as they are emission free. The overall safety of the worldwide fleet is 4 times safer than solar or wind power generation. The PWR was not intended to be scaled up to Utility Scale usage due to several issues and they can't be made efficiently on an assembly line: http://energyfromthorium.com/2011/03/20/1962-aec-report/

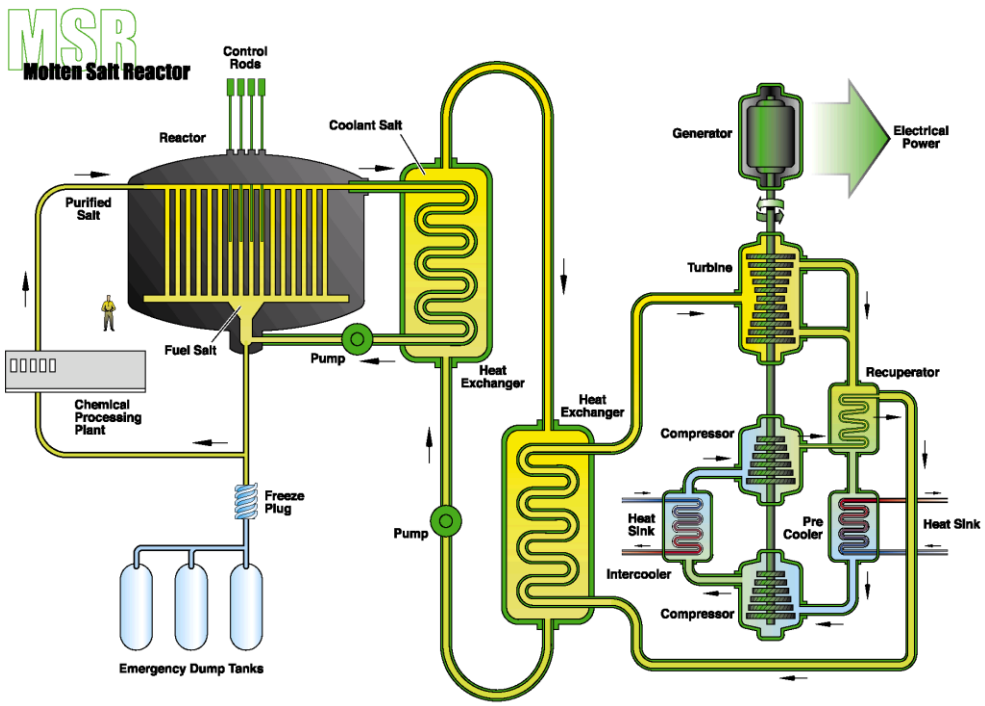
- High Pressure Water issues
  - Need a very expensive containment dome to handle a steam explosion
  - Need 150 atmosphere plumbing, very expensive to build and certify
  - Need for triple redundant water and power backup to keep the core under water upon any plumbing fault.
  - When a core is under cooled, its heat can crack water into Hydrogen and Oxygen -- an explosive mix
- Solid fuel
  - Is about 95% not fission fuel
  - Must shut down to reload and re-configure the fuel about every 18 months
  - Produces more waste when expended must be removed from the reactor to be stored or reprocessed elsewhere.
  - Recycle the nuclear fuel for use in current and future reactors as 97% of the fuel is discarded; there is enough fuel to run the US Fleet for 70 years.


light water reactor
250 tons of uranium containing 1.75 tons of uranium-235
35 tons of enriched uranium (1.15 tons of uranium-235)
215 tons of depleted uranium-238 (0.6 tons of uranium-235)
uranium-235 is burned; some plutonium-239 is formed and burned
35 tons of spent fuel stored containing:
33.4 tons of uranium-238
0.3 tons of uranium-235
1.0 tons of fission products
0.3 tons of plutonium
liquid fluoride thorium reactor
1 ton of thorium
fluoride reactor converts thorium-232 to uranium-233 and burns it
1 ton of fission products
in 10 years, 83 percent of fission products are stable
17 percent of fission products are stored for approximately 300 years
0.0001 tons of plutonium

The Liquid-Fuel Reactor Molten Salt Reactor (MSR)

Aircraft assembly line production of emission free MSRs

- Can't melt down
  - The fuel is mixed with Molten Salt thermal fluid; stable to 1500 C
- Can't blow up
  - Low Pressure
  - Doesn't use water
- Walk-away safe
  - If the plant has a problem, a magnetic drain opens or a fan-cooled freeze plug melts and the reactor fluid drains by gravity into safe cooling tanks.
  - No operator needed for automatic shut down
- One-third the cost to build due to its inherent safety of low-pressure design
  - No pressure dome needed to handle 150 atmosphere steam explosions
  - No 150 atmosphere plumbing & triple redundant cooling systems
  - Higher thermal efficiencies allows lower cost generation options
  - Online fueling and removal of Xenon and other unwanted elements
- Co-generation Thermal without emissions
  - Desalinization and Water Treatment
  - Petrochemical process heat
  - Landfill to clean fuels
  - Coal to aviation gas
- Can make fuel from Thorium: Rare Earths Elements processing discards 15,000 tons of the super fuel Thorium yearly, **enough to power the whole planet using MSRs.**



Stanford Research Institute International's Cubic Mile of Oil

17,000 children under age 5, daily die due to lack of clean electricity; due to indoor cooking with dung or coal and lack of clean water & refrigeration. The World needs emission free energy https://youtu.be/CpXG3zyg3gk

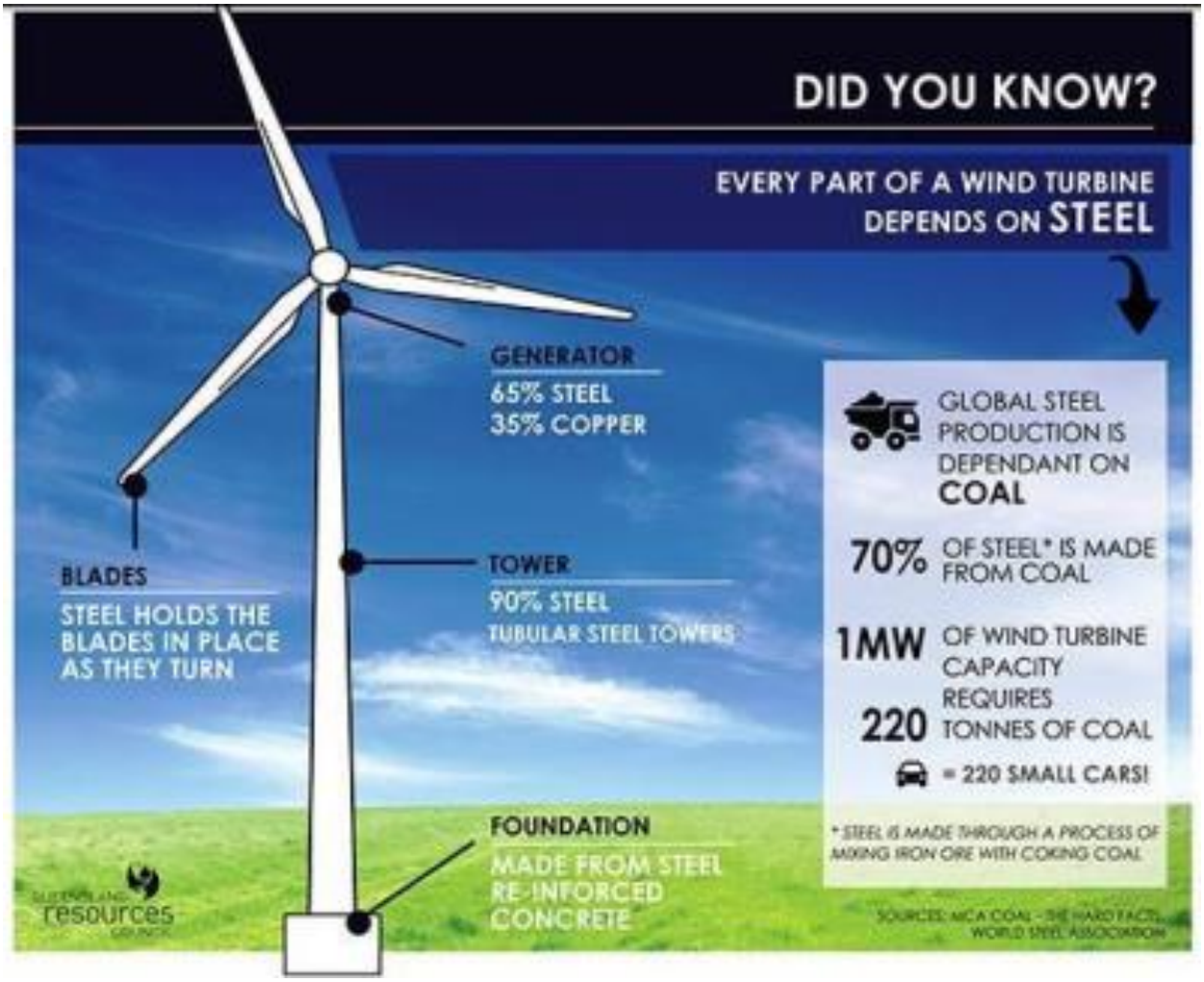
Producing 1 CMO Per Year from Various Sources

Enormous task requiring trillions of dollars over decades

- **Hydro: 200 dams**
  - 1 every quarter for 50 years
  - 18 GW with 50% availability (3 Gorges Dam)
- **Nuclear: 2,500 plants**
  - 1 a week for 50 years
  - 900 MW with 90% av.
- **Solar CSP: 7,700 solar parks**
  - 3 a week for 50 years
  - 900 MW with 25% av. (10X Andasol)
- **Windmills: 3 million**
  - 1200 a week for 50 years
  - 1.65 MW with 35% av.
- **Solar Roofs: 4.2 billion**
  - 250k roofs a day for 50 years
  - 2.1 kW with 20% av.

Currently Mankind uses 4 Cubic Miles of Oil energy equivalent yearly. To eliminate energy poverty we need to add 3-5 CMOs by 2050. For planet to be run by 100% of emission free energy - multiply the above by seven to nine times by 2050, to replace all fossil fuel energy sources. Clearly RE is too material resource intensive for the task.

Bad Wind


DID YOU KNOW?
EVERY PART OF A WIND TURBINE DEPENDS ON STEEL
GENERATOR
65% STEEL
35% COPPER
BLADES
STEEL HOLDS THE BLADES IN PLACE AS THEY TURN
TOWER
90% STEEL
TUBULAR STEEL TOWERS
FOUNDATION
MADE FROM STEEL RE-INFORCED CONCRETE
GLOBAL STEEL PRODUCTION IS DEPENDANT ON COAL
70% OF STEEL* IS MADE FROM COAL
1MW OF WIND TURBINE CAPACITY REQUIRES 220 TONNES OF COAL
= 220 SMALL CARS!
* STEEL IS MADE THROUGH A PROCESS OF MIXING IRON ORE WITH COKING COAL
resources

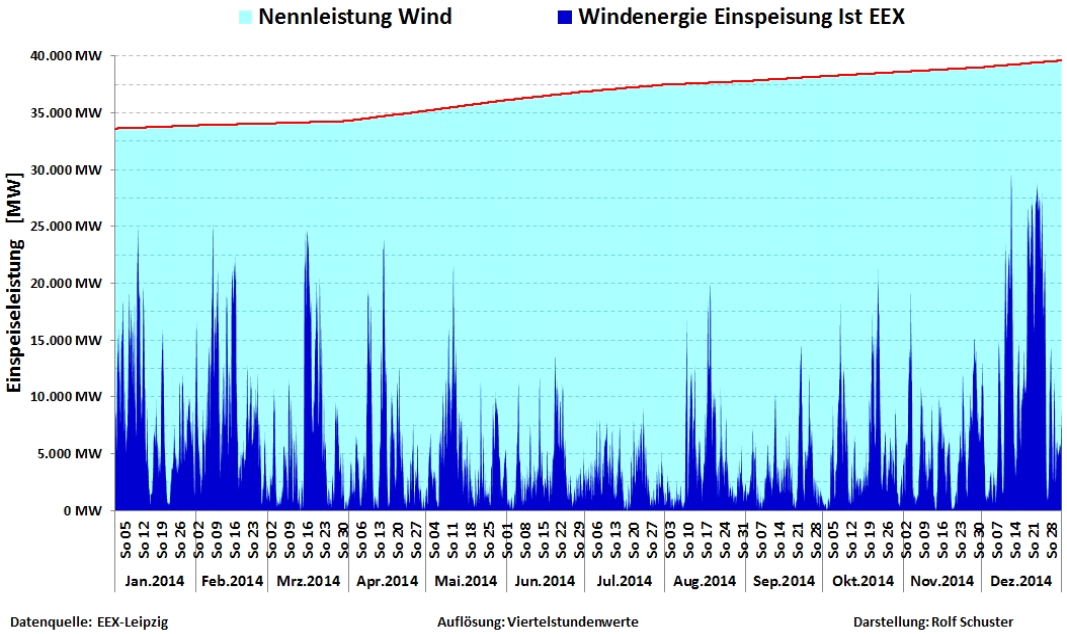
Warren Buffet told an audience in Omaha, Nebraska recently. **"For example, on wind energy, we get a tax credit if we build a lot of wind farms. That's the only reason to build them. They don't make sense without the tax credit."**

- Tower: tower base:
  - Steel 165 ton
- Blades: 57m.
  - Steel: 5.4tons
  - Carbon Fiber: 3.69 tons
  - Cast Iron: 8.5 tons
  - Fiberglass/ 7.96 tons
- Nacelle 12m
  - Steel: 165 tons
  - Fiberglass/ 6.4 tons
  - Copper : 2.34 tons
  - Aluminum: .54 tons
  - Cast Iron: 16.47 tons
  - Rare earths: about 1 ton

In 2008, utilities and manufacturers installed more than 5,000 utility scale wind turbines in the United States, requiring more than 1.1 million metric tons (Mt) (1 million short tons) of iron and steel, 920,000 cubic meters (1.2 million cubic yards) of concrete, 2.4 million steel bolts, and 43,000 kilometers (km) (27,000 miles) of reinforced steel rebar (American Wind Energy Association, 2009b).

Regardless of how cost factors are considered, the true cost of wind energy in the United States is, on average, 48 percent higher than most estimates claim. This is because generating electricity from wind power entails many hidden costs. A true estimate of the cost of wind power to the American public must account for the following factors: The federal PTC, a crucial subsidy for wind producers, has distorted the energy market by artificially lowering the cost of expensive technologies and directing taxpayer money to the wind industry. States have enacted Renewable Portfolio Standards (RPS) that requires utilities to purchase electricity produced from renewable sources, which drives up the cost of electricity for consumers.

German Wind Power Output 2014



Wind resources are often located far from existing transmission lines. Expanding the grid, whether by private or public funding, is expensive, and the costs are passed on to taxpayers and consumers. **Because wind power is unreliable, conventional generators must be kept on backup to meet demand when wind is unable to do so.** This drives up the cost of electricity for consumers, as two plants are kept running to do the job of one. Billions of taxpayer dollars are used to subsidize the wind industry. Allowing consumers to pick which energy to use, based on price, would result in greater economic efficiency than allowing government to decide how the resources of consumers should best be allocated.

Wind Capacity, Batteries, Land Area and Natural Resources

Electricity makes our industries, jobs, travel, communication, living standards, health and safety possible, and demand will certainly grow as more nations electrify, and more vehicles are battery-powered.

Some fundamental assumptions: Wind turbines replace 100% of today's 2.85 TW global electricity generation, by some future date – as many activists and politicians insist we must (and can) do. Turbines are all 1.8-MW nameplate power. Average turbine capacity factor gradually falls from 33% to 16.5% as the best wind sites are utilized, and much poorer sites must be developed.

In the USA many of the best wind sites are off the Washington-to-California and Maine-to-Georgia coastlines, and in the Great Lakes, where water depths and powerful local opposition would make it impossible to install many turbines. Onshore turbine size is limited by the size of blades that can be hauled by trucks on winding roads. The same situation would likely apply around most of the globe.

Further assumptions: One-third of turbine output powers society; two-thirds charge batteries that provide power for 48 of every 72 hours that wind is not blowing. And winds always cooperate with that scheme – always arriving just in the nick of time, as batteries are depleted, and never disappearing for more than two days, even during sweltering summers or frigid winters when demand soars but winds disappear.

Of course, most of these assumptions exist only in the realm of fairies, pixie dust, green energy utopia and easy number-crunching. They are meant to initiate important analyses and debates that climate alarmists, renewable energy proponents, legislators and policy makers have never conducted.

Using these assumptions, generating 25 billion megawatt-hours would require 1.6 million 1.8-MW turbines functioning at full 1.8-MW capacity in strong winds, all day, every day, with no worries about storage. If they operate only eight hours a day (33% engineered capacity), we just use electricity when it's available, instead of when we need it. But that's terribly inconvenient and disruptive.

So we employ the Dr. Hayden system, instead. We erect 4.8 million turbines that operate steadily for eight hours, sending one-third of their electricity to the grid and two-thirds to batteries. That would yield 8 hours of direct power while the wind is blowing (33% capacity factor) – and let us draw power from the batteries for the next 16 hours, until the wind regularly picks up again. "I love magic," he says.

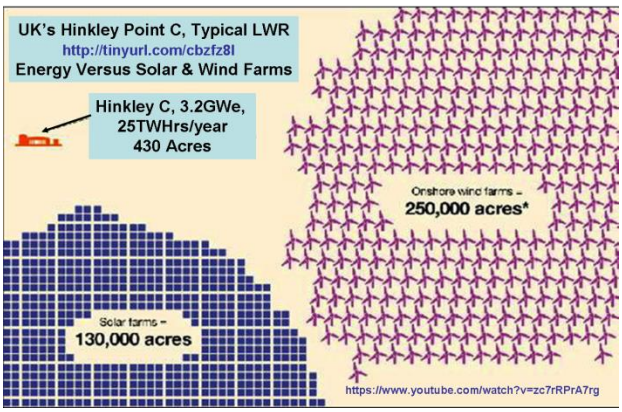
That clearly won't work. We really need at least 48 hours of storage – and thus three times as many turbines, under a similar arrangement, but providing more flexibility, to recognize unpredictable wind patterns and the likelihood of two windless days in a row. We're up to 14.4 million 1.8-GW turbines.

Want a bigger safety net? For seven days of windless days, it will take 50 million turbines. But then we're really into the mediocre wind sites. Capacity plummets to 16.5% or so. Perhaps 100 million turbines will do the trick.

That would also ensure that electricity generation is close to our big urban centers – hence shorter transmission lines, and less cement, steel, copper, et cetera to build the power lines. It's a win-win situation, except for those who have to look at or live next to turbines and transmission lines, of course.

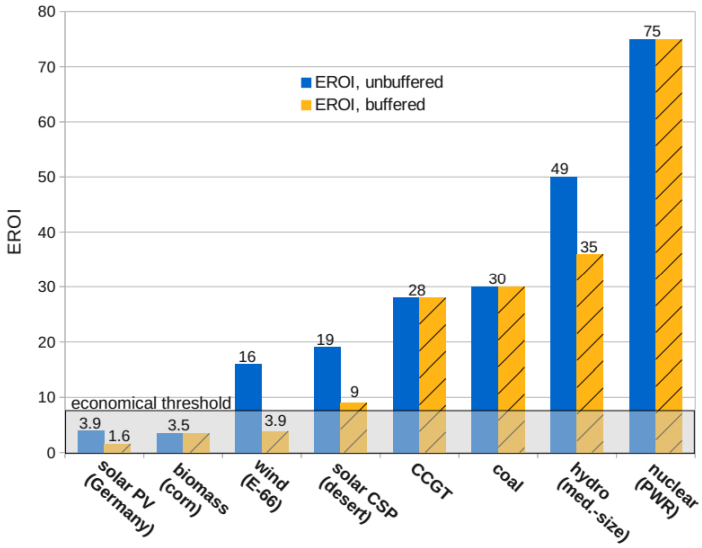
How much land are we talking about, to generate 25 billion megawatt-hours of global annual electricity? Assuming top quality wind sites, at 5 kilowatts per acre (average output per land area for any turbine at the windiest locations), onshore turbines operating 24/7/365 would require some 570 million acres.

Nuclear Power vs. Solar/Wind



That's 25% of the United States – or 30% of the Lower 48 US states. It's almost all the land in Washington, Oregon, California, Idaho, Nevada, Montana, Wyoming, Utah and Arizona combined! Change the assumptions – change the numbers. To store electricity for windless days, total power generation (and thus turbine numbers and land acreage) begins to skyrocket. For 48 hours of backup, triple the power generation; that's the entire Lower 48. For a full week of backup, add in Canada.

Transmission and Storage



How many batteries? Storing 1 gigawatt-hour (GWh) of electricity – to provide power for 48 windless hours for a US city of 700,000 people – would require 480,000 of Tesla's new 100-kWh lithium-ion battery packs. Backing up 2.85 TW for just two windless days would require 1.4 trillion Tesla units!

Just imagine the land, raw materials, mining, manufacturing and energy that would be needed to make all those batteries (and replace them every few years). As energy and technology analyst Mark Mills has noted, all the world's existing lithium battery factories combined manufacture only a tiny fraction of that.

I'm sure the world's battery makers would be more than happy to take our hard-earned taxpayer and consumer cash to build more factories and make all those batteries – to save us from dangerous climate change that is no longer governed by the sun and other powerful natural forces.

Let's get real. It's time to stop playing with pixie dust and renewable energy utopia schemes. Time to open our schools and legislatures to actual thinking about energy, sustainability, climate change and what makes our jobs, health and living standards possible. It is time for full-bore studies and legislative hearings on all these issues – in the USA, UK, EU and everywhere else.

Sustainability and renewable energy claims are too grounded in ideology, magic and politics. Wind and solar energy forecasts ignore the need to find and mine vast new metal and mineral deposits – and open US lands that are now off limits, unless we want to import all our wind turbines, solar panels and batteries. They assume land use impacts don't really exist if they are in other people's backyards. Worse, too often anyone trying to raise these inconvenient truths is shouted down, silenced, ignored. That has to stop. The stakes are too high for ideology and pixie dust to drive fundamental public policies.

http://peakresources.blogspot.com/2014/11/in-search-of-alternative-energy.html

https://wattsupwiththat.com/2017/09/03/revisiting-wind-turbine-impacts-erroneous-recent-calculation-highlights-need-to-assess-renewable-energy-sustainability-claims/

Raptors, Bats and Humans

Since the early 1980s, the industry has known there is no way its propeller-style turbines could ever be safe for raptors. With exposed blade tips spinning in open space at speeds up to 200 mph, it was impossible. Wind developers also knew they would have a public relations nightmare if people ever learned how many eagles are actually being cut in half – or left with a smashed wing, to stumble around for days before dying.

To hide this awful truth, strict wind farm operating guidelines were established – including high security, gag orders in leases and other agreements, and the prevention of accurate, meaningful mortality studies.

http://www.cfact.org/2013/03/18/wind-turbines-kill-up-to-39-million-birds-a-year/

"Scientists & engineers share an implicit oath to truth and facts for the benefit of society. This plan violates that oath and is a marketing effort to mislead folks and serve GE & others who don't care about the urgency of wise environmental choices today."

Dr. Alex Cannara

Human & Environmental impact by Wind

- http://oto2.wustl.edu/cochlea/wind.html
- https://www.wind-watch.org/documents/negative-health-impact-of-noise-from-industrial-wind-turbines-the-evidence/
- http://www.windawareireland.com/environmental-issues/
- https://www.scientificamerican.com/article/wind-power-found-to-affect-local-climate/

Wind Effectiveness is Over Blown

The true cost of wind energy is higher than most cost estimates calculate. Mandates requiring the use of wind energy increase electricity costs for consumers and subsidies mask the actual cost of doing so. RPS require intermittent renewable energy to exist, but at the expense of utilities and consumers. The PTC makes wind power cheaper for utilities and consumers, but at the expense of taxpayers. Through such policies, U.S. policymakers have essentially decided that electricity consumers will have wind power, even if it is more expensive. The cost of this decision has fallen to U.S. taxpayers and consumers of electricity. When weighing the costs and benefits of wind power, not including all of the hidden costs makes wind power appear to be a more attractive option than it actually is.

Energy policy decisions, however, should be based on a more complete estimate of the cost of wind energy.

file:///F:/Thorium/New%20Energy/True-Cost-of-Wind1.pdf

Solar Fallacy

Modern solar panels are about 20% efficient. This just means that 20% of the energy in solar radiation is converted into electricity, while the rest is lost as heat. Even though this is actually quite decent, we would nevertheless need to completely cover an **area the size of Spain** in solar panels to generate enough electricity to meet global energy demands by 2030. This is clearly an enormous waste of land—it would be better to preserve that land, and instead switch to nuclear power, or stick with fossil fuels. Even if we wanted to cover that much land with solar panels, we couldn't.

Why? There's simply not enough silver to do it. Let's run through the numbers. Silver is a critical element in solar panels. In fact, roughly **20 grams** of silver goes into an average solar panel, which is **1.8 square meters**. Given that there are 1 million square meters in a square kilometer, this means that we would need 11.1 million grams, or 11.1 tons, of silver per square kilometer of solar panels.

Spain is 506,000 square kilometers in area—which is how much area we'd need to cover in solar panels. This means that **5,616,600** tons of silver would be required to build enough solar panels to power the world. Right now, humans only have only mined, and have access to a total of 777,275 tons of silver this isn't even close to enough silver to build enough solar panels. That is **7.2 times more than exists in the Earth's crust**, even if solar panels became four-times as efficient we still couldn't do it.
https://www.nationaleconomicseditorial.com/2017/06/05/solar-powered-future-impossible/

Solar power: We've read many articles claiming that solar power is at "grid parity" or "cheaper than coal". It is true that solar power is sold to utilities for as little as 5 cents/kWh, but there is another money flow, too. A solar generator company not only sells energy, measured in kWh, but also sells SRECs (solar renewable energy credits). For every 1000 kWh delivered the generator is awarded one SREC, a certificate of cleanliness for the energy delivered. The energy and SRECs are sold separately.

Many states require their utilities to derive a certain percentage of electric power from solar. If the utility does not generate solar power it can instead buy SRECs, rather like carbon offsets. The SRECs are sold at auction, lately at $300 per SREC. The utilities buy SRECS, just as they buy power. The costs are put into the rate base and spread over electricity bills for all consumers.

A typical PV solar generator might receive these two payments for generating one kWh of electricity. - $0.05 for the energy - $0.30 for the SREC

"That is to say, the SREC costs 6X the kWh of energy costs. Making claims that PV solar costs 5 cents/kWh is misleading if the utility is paying 35 cents for it. This creates an oversupply and the situation gets really complex, allowing SRECs to be applied to future years. Does anybody remember Enron?" Robert Hargraves

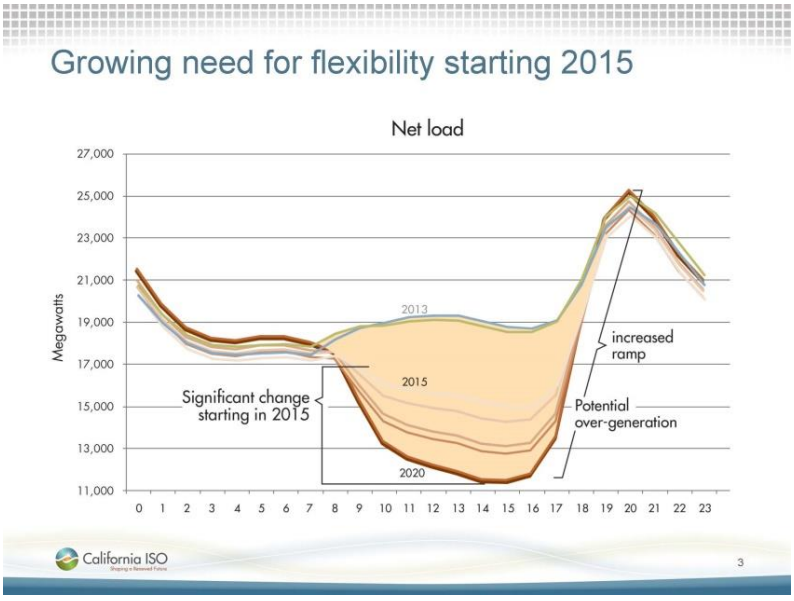
http://programs.dsireusa.org/system/program/detail/5679

Solar Photovoltaics

	GW installed	TWh consumed	24/7/365.25 TWh maximum output	Load factor %
USA	7.3	4.4	64.1	6.86
Czech republ	2.1	2.2	18.2	12.11
France	3.7	4.0	32.4	12.36
Germany	32.6	28.0	286.1	9.79
Italy	16.2	18.5	142.4	12.99
Portugal	0.2	0.4	1.9	21.52
Spain	4.5	11.9	39.8	29.92
UK	1.7	1.3	14.5	8.96
Australia	2.4	2.8	21.1	13.26
China	8.3	4.5	72.8	6.18
Japan	6.9	6.2	60.6	10.23

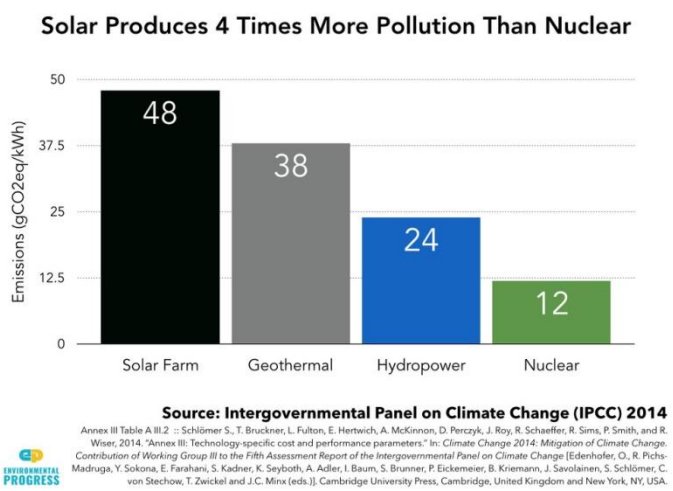
Every megawatt of solar power must be backed up by coal or natural gas generators. Otherwise our offices, hospitals, assembly lines, televisions and internet go on and off constantly. No one can work or live that way.

The backup power plants must be running on standby (spinning reserve) all the time – then must ramp up to full power every time the sun stops shining. That slashes their efficiency, and sends their fuel costs and emissions skyrocketing. Any supposed energy, sustainability and climate benefits disappear.



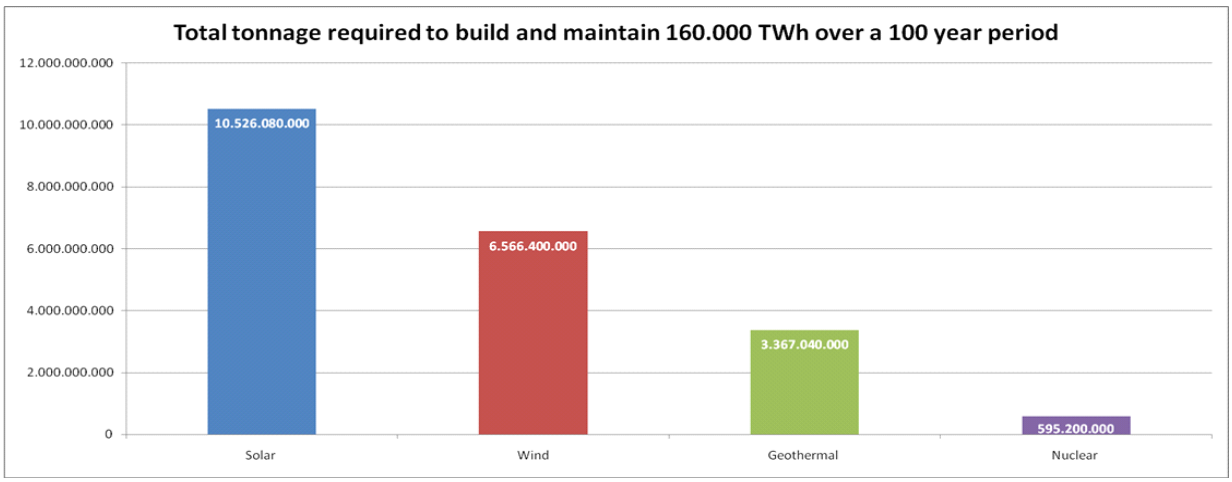
Moreover, it is highly unlikely that any solar array can ever generate enough electricity over its entire life span to equal the energy that went into making, installing and servicing the panels. Mining the raw materials, turning them into metals and other panel components, hauling and installing the panels – all require enormous amounts of motor fuels, coking coal and electricity. The balance sheet is in the red.

Add in what it takes to build fuel and operate the backup power plants, solar is bankrupt.


Solar Produces 4 Times More Pollution Than Nuclear
Emissions (gCO2eq/kWh)
50
37.5
25
12.5
0
48
38
24
12
Solar Farm
Geothermal
Hydropower
Nuclear
Source: Intergovernmental Panel on Climate Change (IPCC) 2014
Annex III Table A III.2 :: Schlömer S., T. Bruckner, L. Fulton, E. Hertwich, A. McKinnon, D. Perczyk, J. Roy, R. Schaeffer, R. Sims, P. Smith, and R. Wiser, 2014. "Annex III: Technology-specific cost and performance parameters." In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
ENVIRONMENTAL PROGRESS

If the photovoltaic panels made in China were installed in China, the high carbon intensity of the energy used and that of the energy saved would cancel each other out, and the time needed to counterbalance greenhouse-gas emissions during manufacture would be the same as the energy-payback time. But that's not what's been happening lately. The manufacturing is mostly located in China, and the panels are often installed in Europe or the United States. At double the carbon intensity, it takes twice as long to compensate for the greenhouse-gas emissions as it does to pay back the energy investments.

Material requirements are often forgotten and/or brushed away as if it's something we don't need to worry about. In 100 years you need to replace wind and solar 4 times, while Geothermal and nuclear only require two replacements. See how the material costs per 10.000 Terawatts TWh add up? How can anyone support solar and wind after you've seen these numbers and you know that you need 160.000 TWh...



"Does anyone believe that it is moral or wise to invest 10.5 Billion Tons of materials in contrast to 600 million Tons? That's 5.6% of the required materials for solar... 9% for wind... and 17% for Geothermal. It also takes energy to mine, refine and process these materials. Manufacturing, transportation, installment and upkeep also require energy and create emissions." Mathijs Becker

To power Earth for future generations,

Let us choose wisely

The least environmental impacting energy source is,

Nuclear

The safest and least resource intensive energy source is

The "Good Reactor"

The Molten Salt Reactor

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Oak Ridge National Lab MSR https://www.ornl.gov/msr

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